# The eRHIC IR and diffractive eA physics

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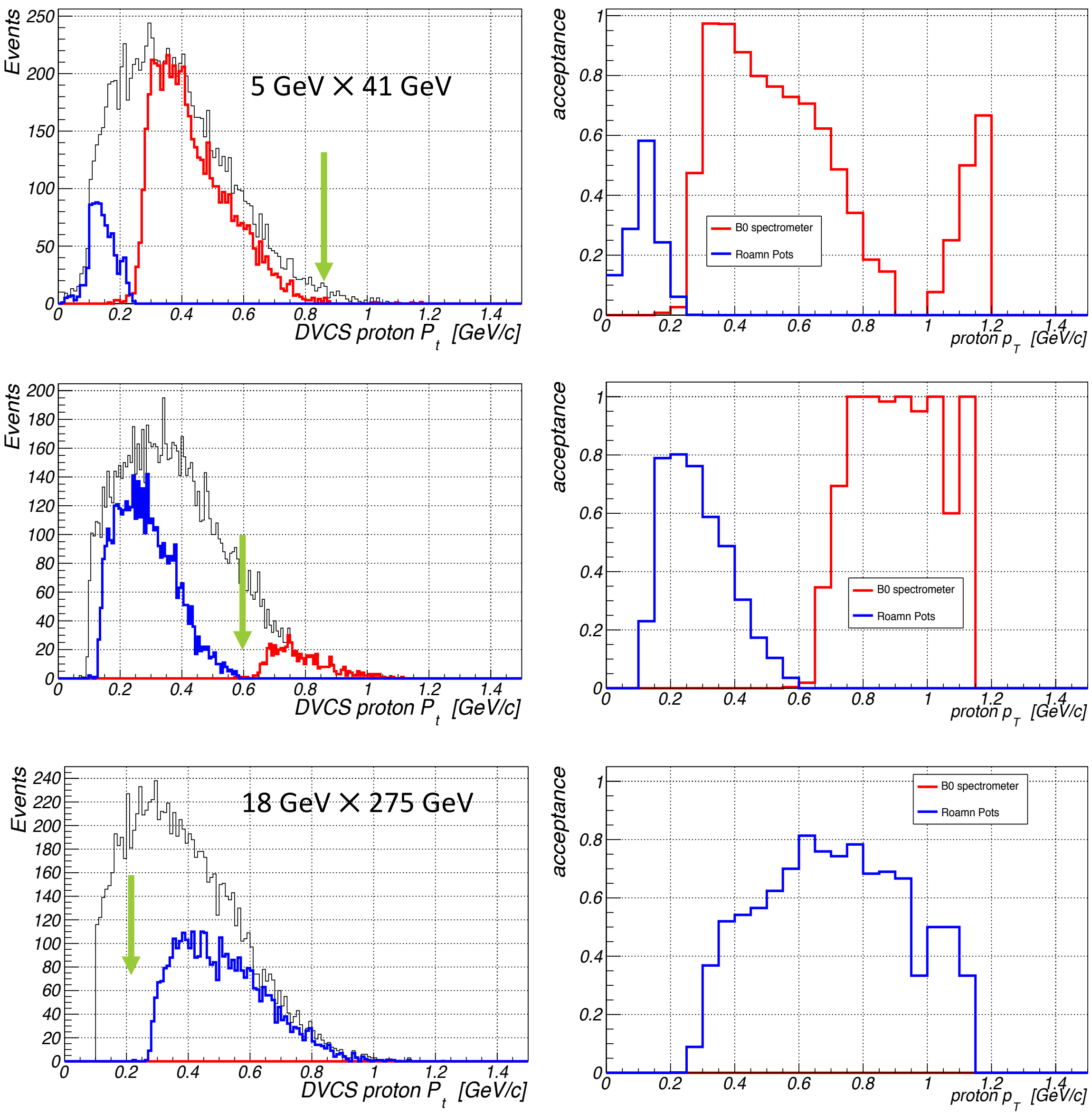
2019/04/03

Note: These plots are for the IR design from the 2018 eRHIC pre-CDR and that we are working on a revised IR design, which will be discussed in the updated pre_CDR

# The $p_T$ acceptance of proton from DVCS process




Protons with scattering angle from 0-5mrad are detected by Roman Pots, while the range from 7 to 20mrad is covered by B0 spectrometer

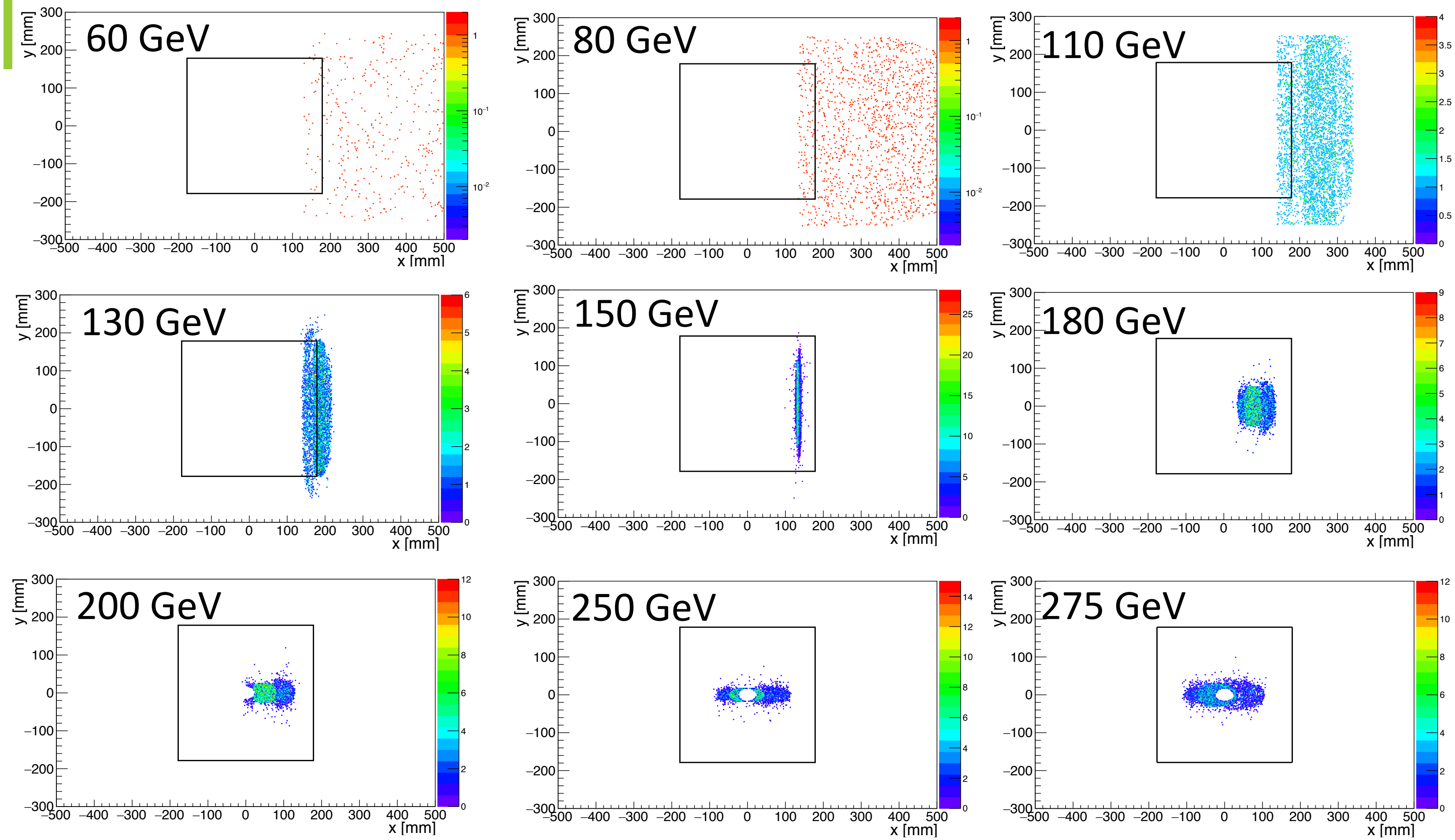
The limiting factors:

- the inner dimension of the vacuum chamber and magnet apertures
- beam pipe
- 10$\sigma$ away cut from beam line

Roman Pots

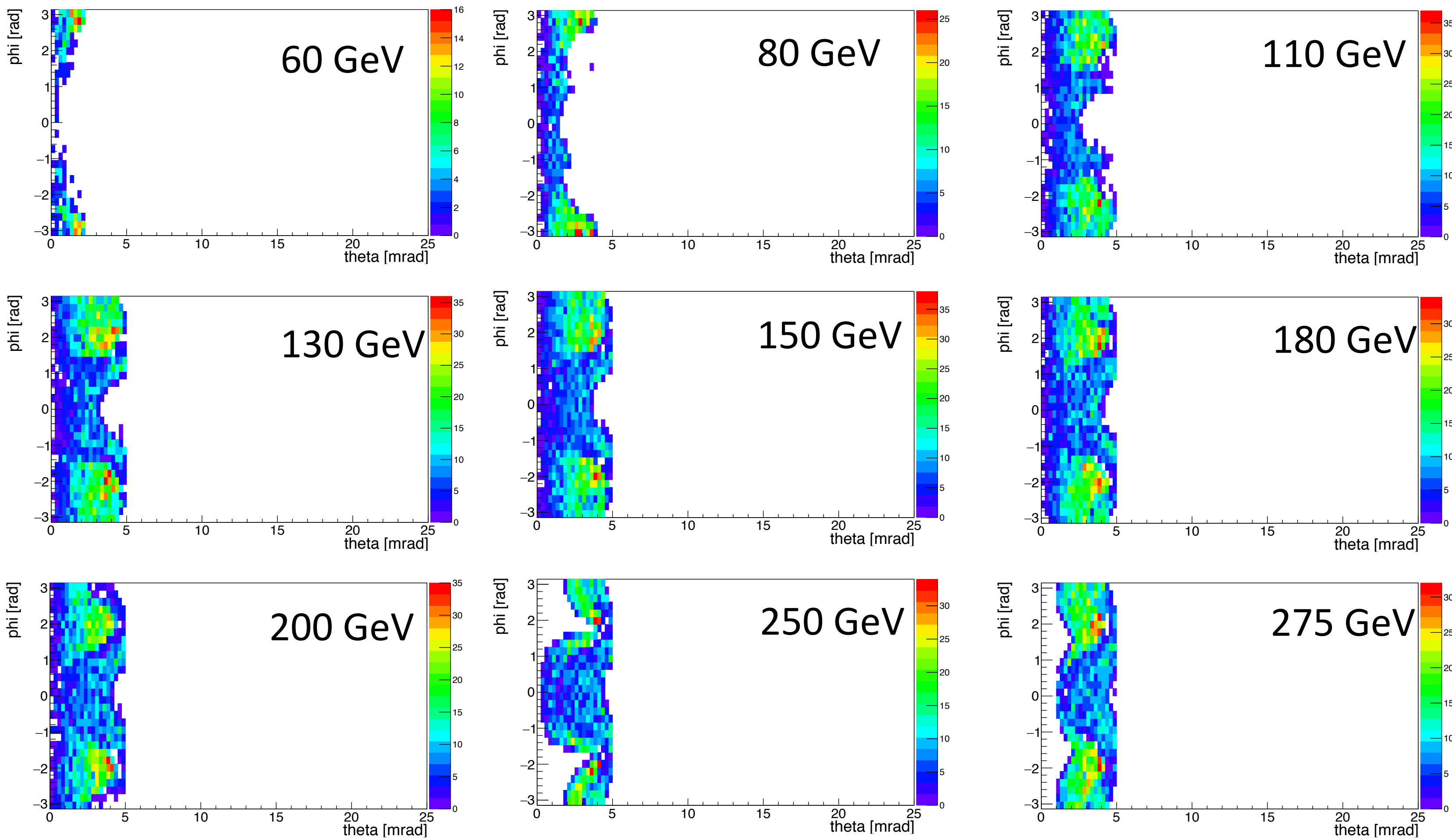
B0 spectrometer

# X_Y distribution at Roman Pots position(fix momentum & theta 0_5mrad)




- Z of Roman Pots: 28.1m; Possible real size: 357mm *357mm
- As the p decreases, the rigidity goes down, and the proton bends more
- The hole in the middle of higher momentum distribution is due to 10$\sigma$ away cut from the beam line

# Theta VS Phi at Roman Pots position(fix momentum & theta 0_5mrad)

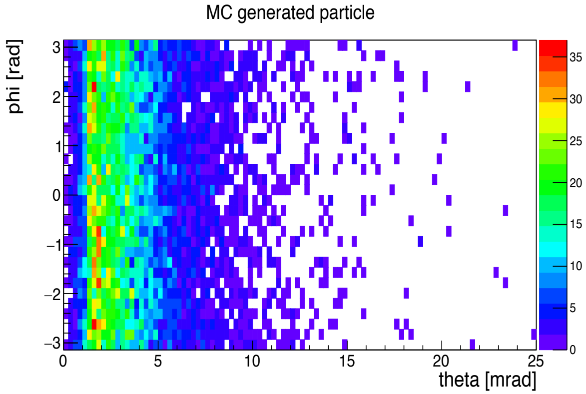



- The lose particles in low momentum is because the magnets bend them away
- The gap at theta ~ 0 for high momentum protons is due to the cut of 10$\sigma$ away from the beam line

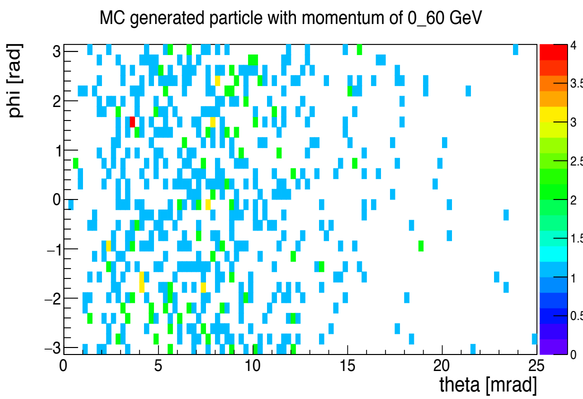
# ePb Data sample

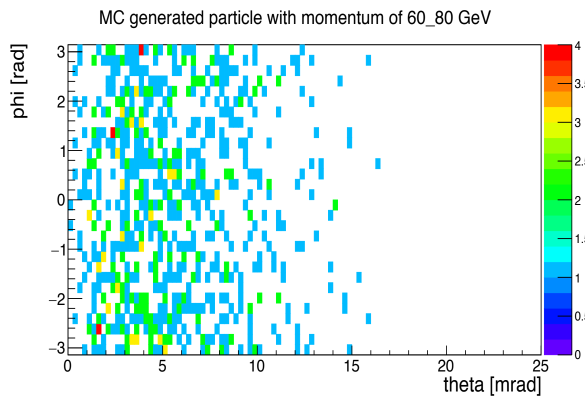
- e+Pb(BeAGLE)
- $18 \times 110$ (GeV)
- $1 < Q^2 < 10$
- $0.01 < y < 0.95$
- 10K events

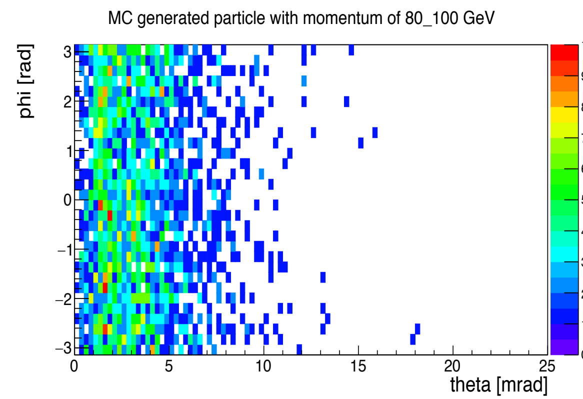
# MC generated protons theta VS phi

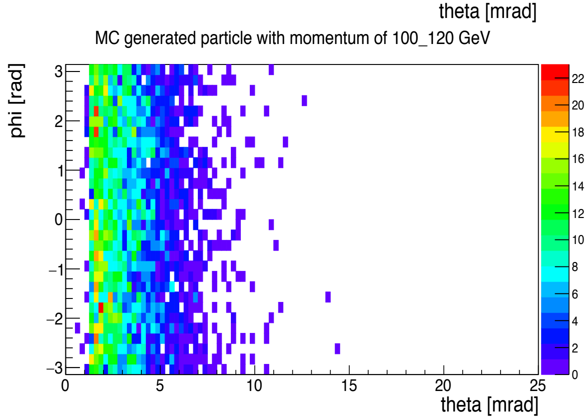


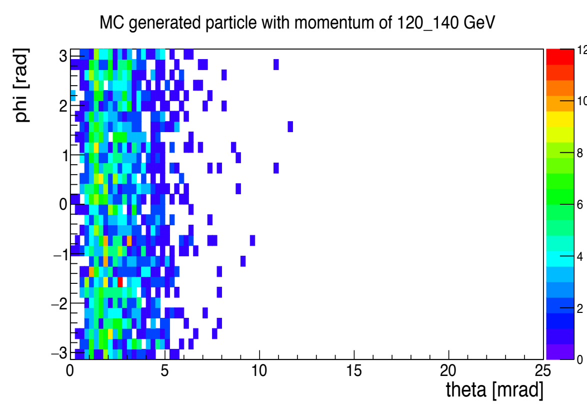

The protons are uniformly distributed in phi

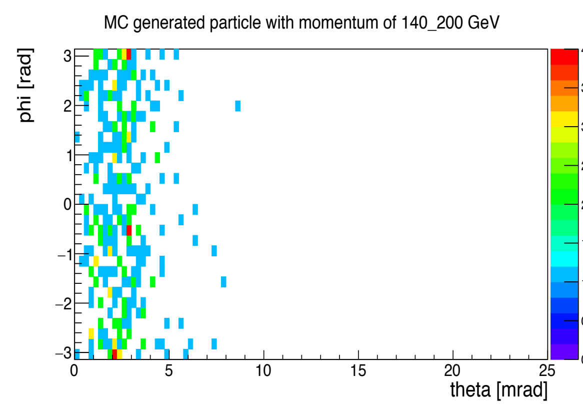


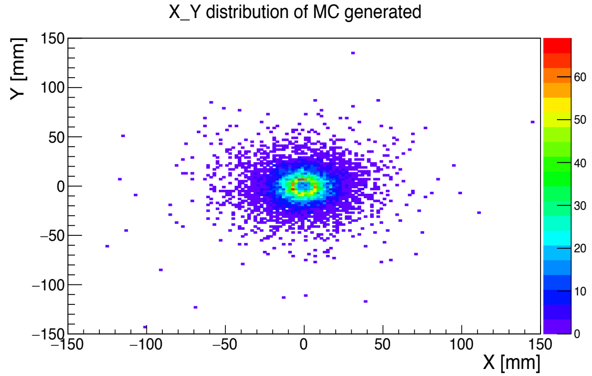



# MC generate particle X VS Y

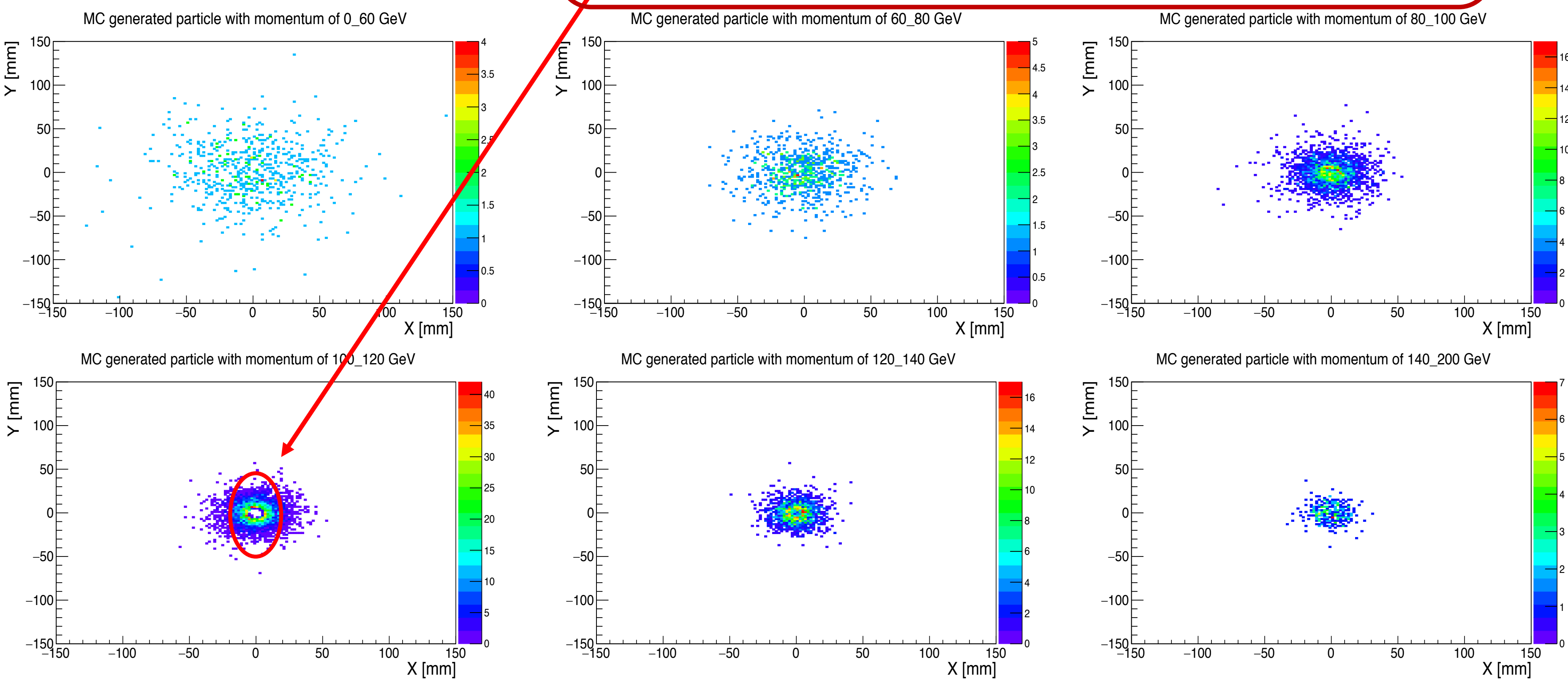



$Z = 4.9m$ (b0: 5.0m-6.2m);

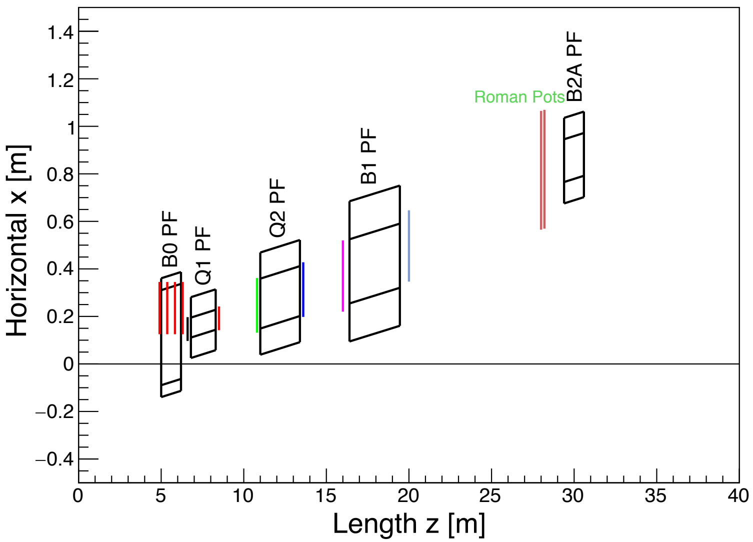
$X = Z * \tan(\theta) * \cos(\phi)$;

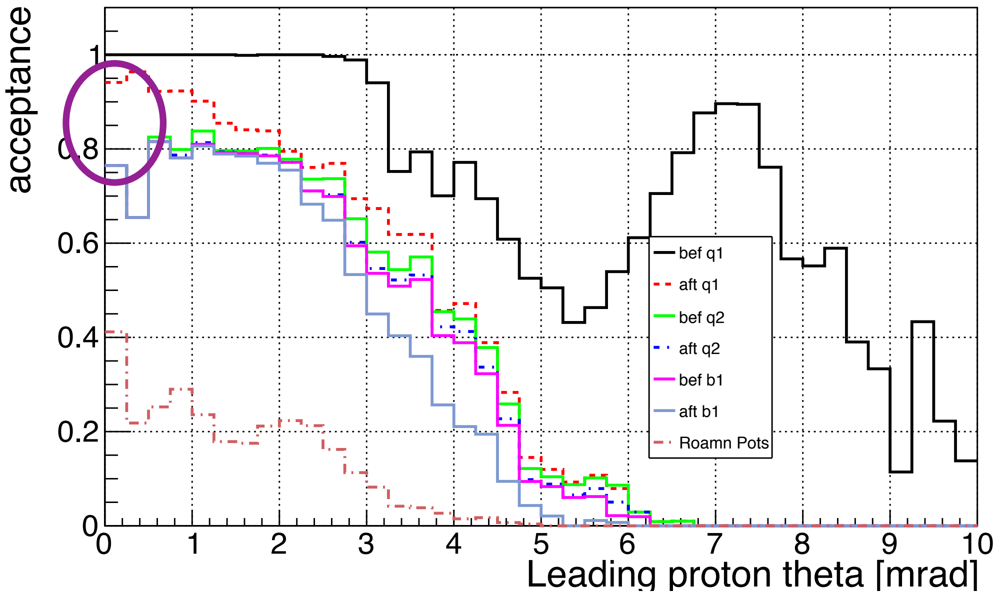
$Y = Z * \tan(\theta) * \sin(\phi)$

Due to the interactions between the outgoing protons and the nuclear remnants, the proton needs some minimum momentum to escape from its mother, so there is some phase space where one doesn't see the protons(91 GeV<$p_z$ <129GeV).



# Acceptance

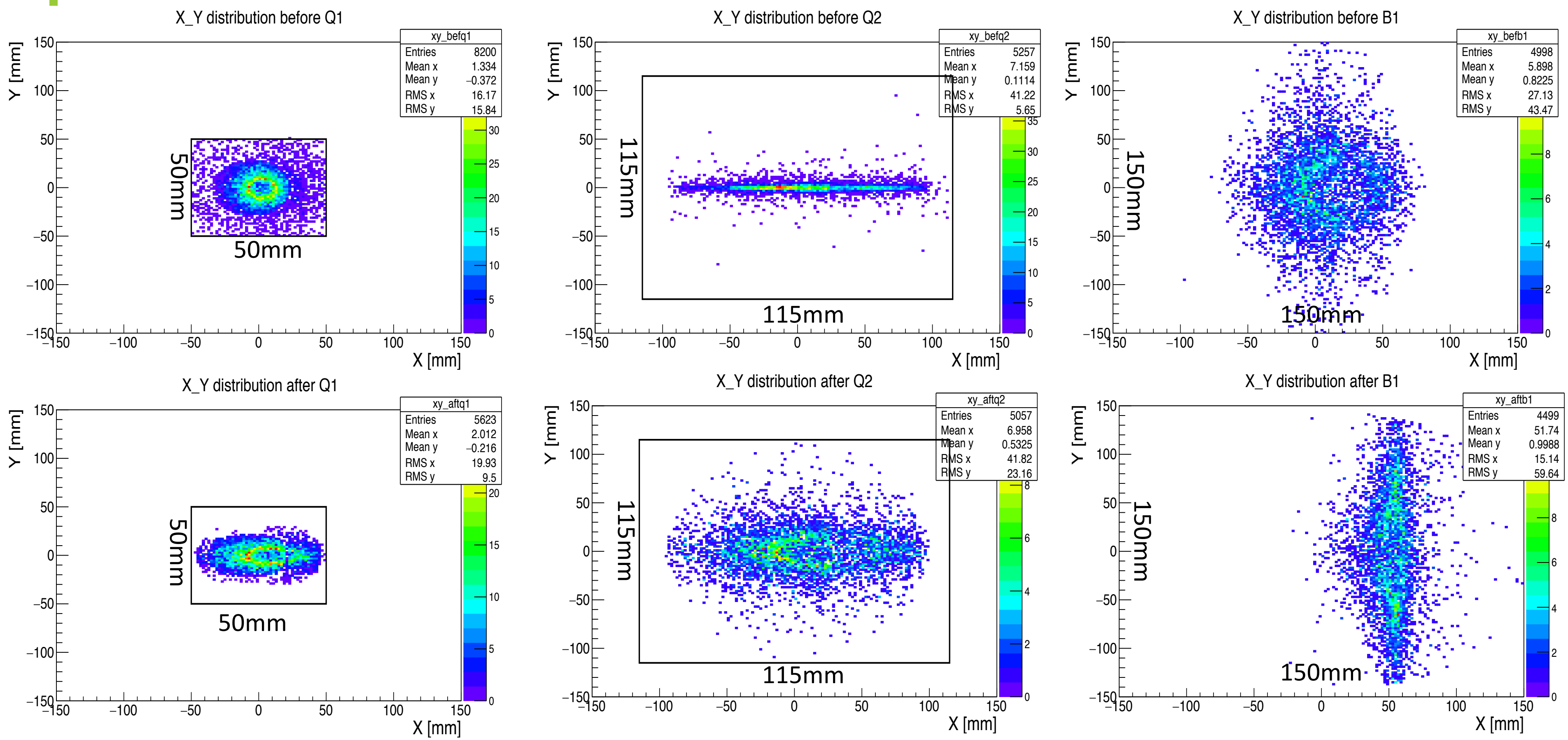



| | Center_ z [m] | Center_ x [m] | $R_{in}$ [m] | Length [m] |
|---|---|---|---|---|
| B0PF | 5.5999 | 0.1237 | 0.200 | 1.200 |
| Q1PF | 7.5498 | 0.1695 | 0.042 | 1.500 |
| Q2PF | 12.1999 | 0.2803 | 0.105 | 2.400 |
| B1PF | 17.9002 | 0.4226 | 0.135 | 3.000 |

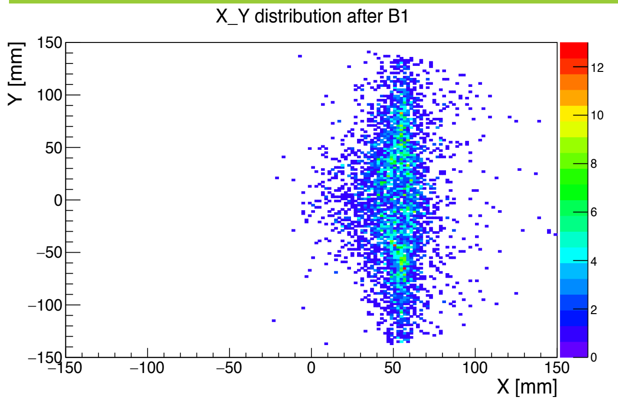
- 20% loss of acceptance in ~0 theta from aft q1 to bef q2.
- Roman Pots have much less acceptance.

# X_Y distribution

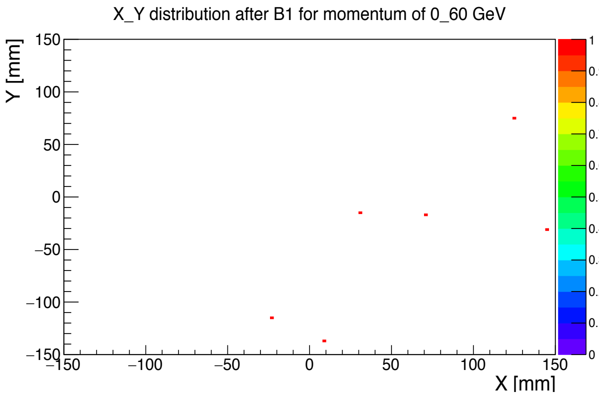


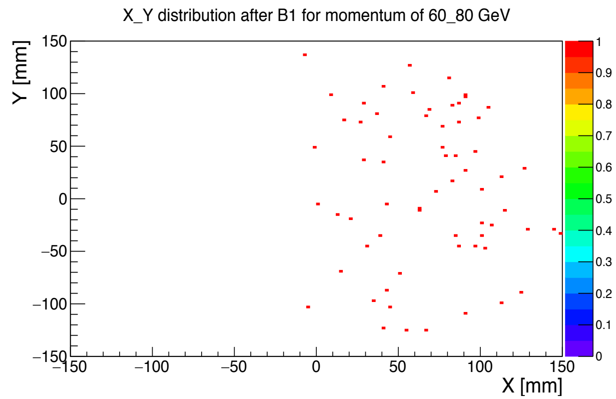

There isn't have 10$\sigma$ away cut here, because we can not put a real detector in the main beam

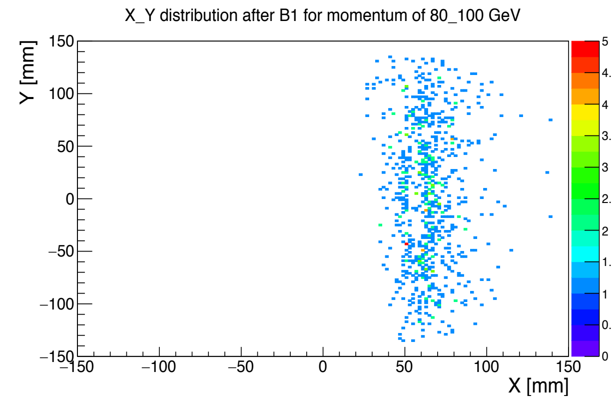
# X-Y distribution after B1

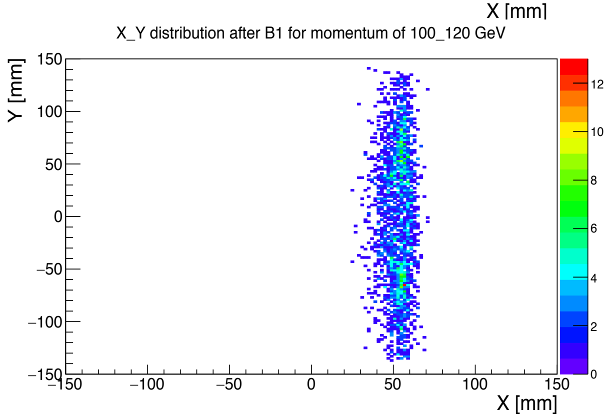


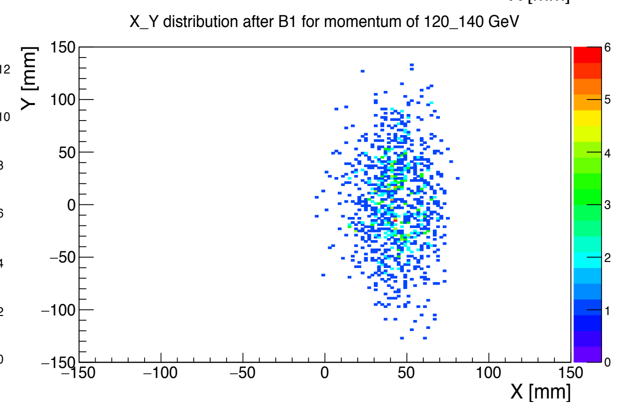

As the p decreases, the rigidity goes down, and the proton bends more

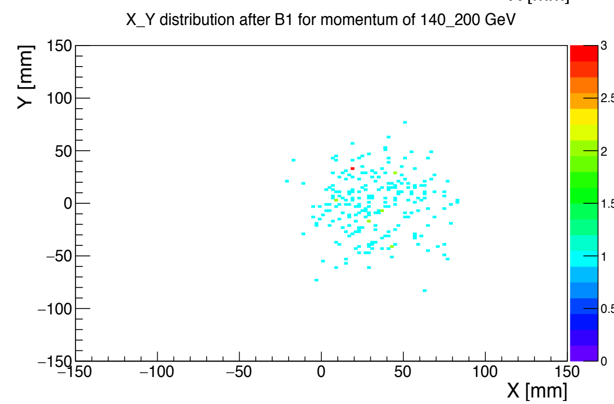


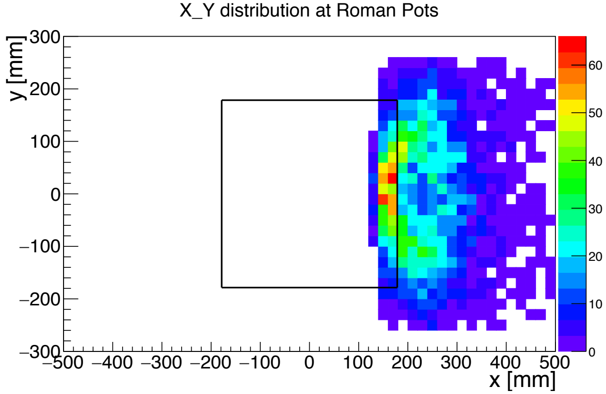



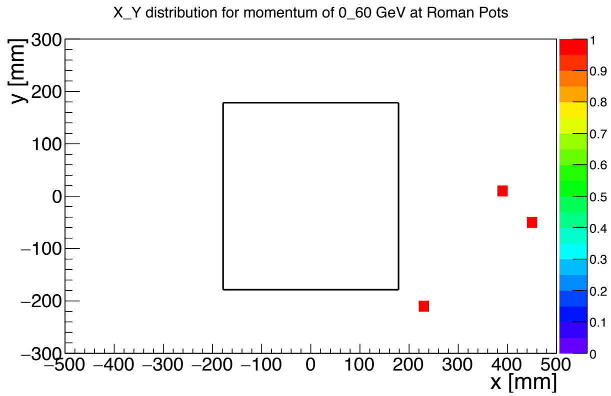



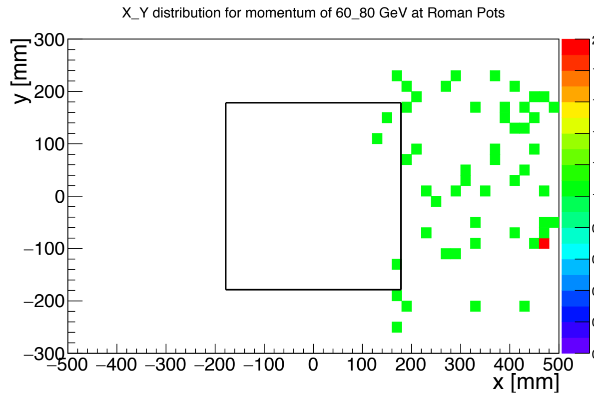
# X-Y distribution at Roman Pots position

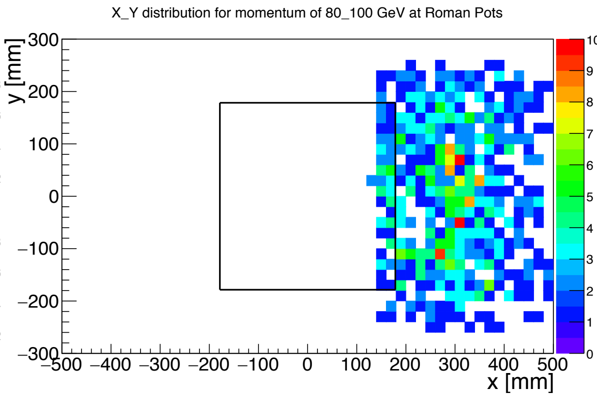


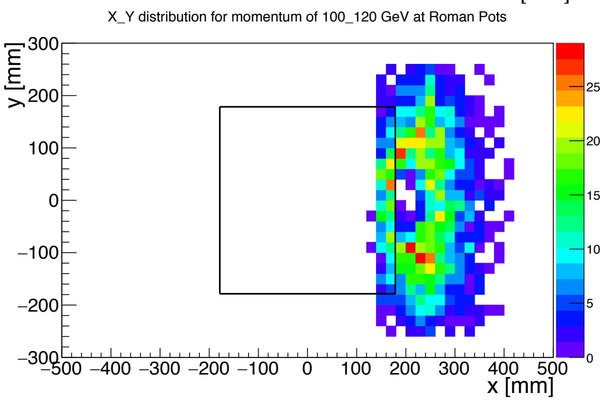

Roman Pots: 28.1m
Possible real size: 375mm *375mm

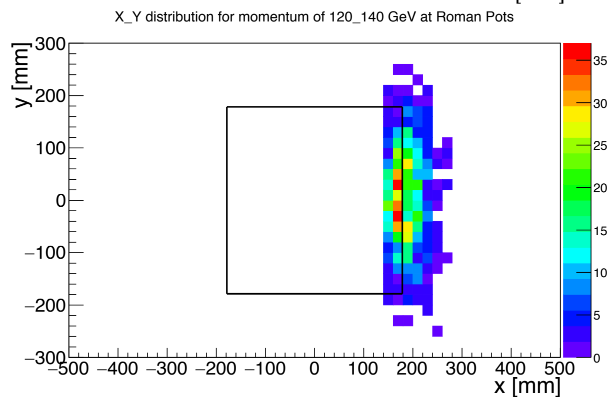
Roman pots have not enough acceptance, need a different detector solution

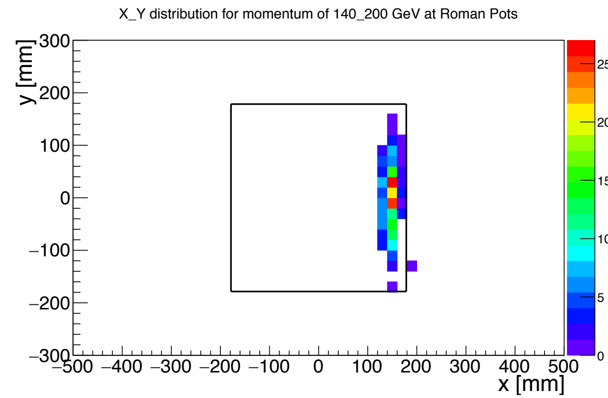


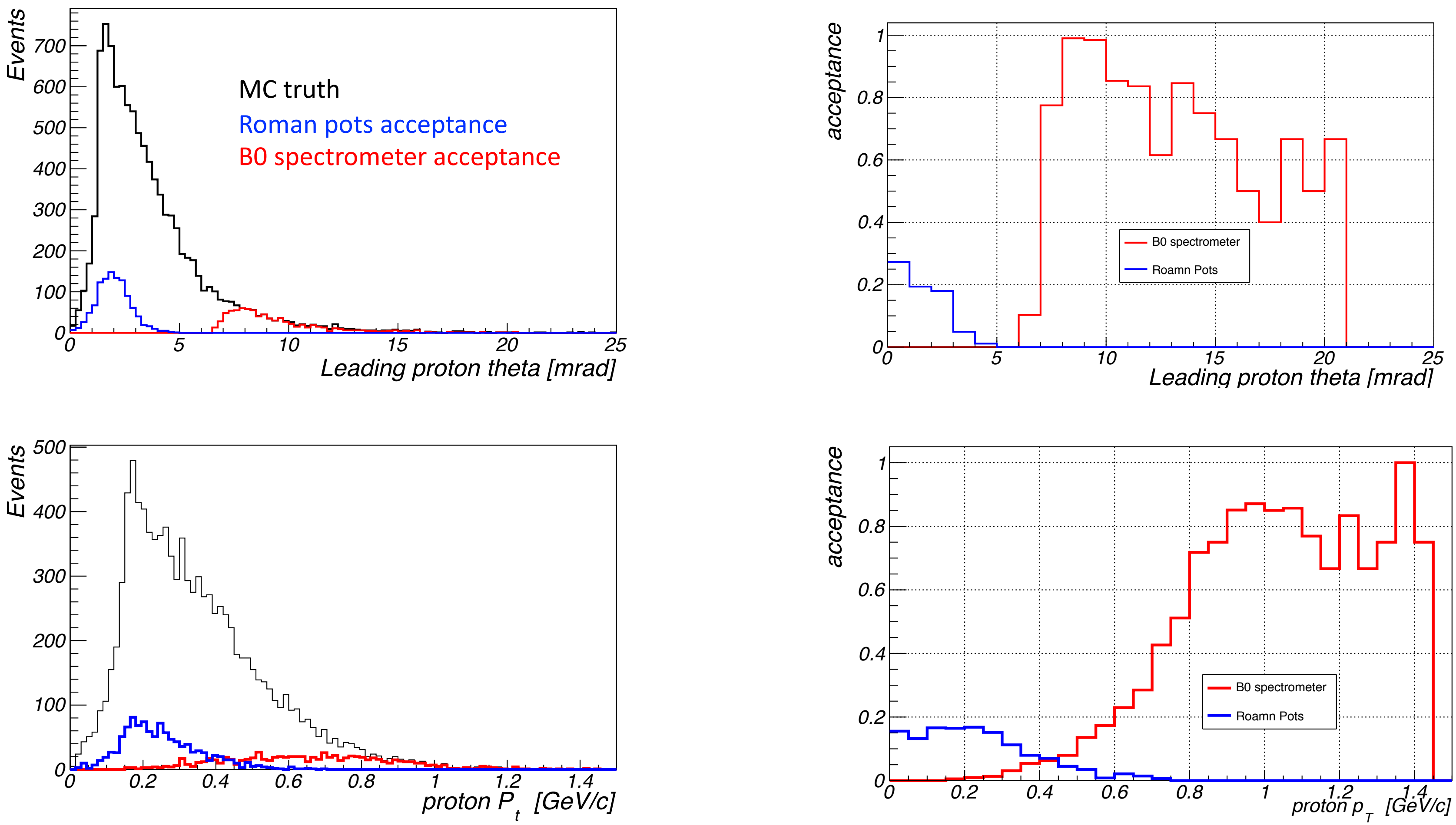



# Proton acceptance in ePb




MC generated: 10K; Roman Pots acceptanced: 1.1K

It's very little statistics at B0, the Roman Pots acceptance for proton is poor

# Summary

- We studied the acceptance of protons in B0 and Roman Pots in ep and ePb collisions.
- The Roman Pots acceptance for protons from Pb-decay is poor, because of the different rigidity between proton and Pb.
- For ePb, we need to have an additional detector, which recovers this loss.

# The comparison between BeAGLE and E665

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# Events information

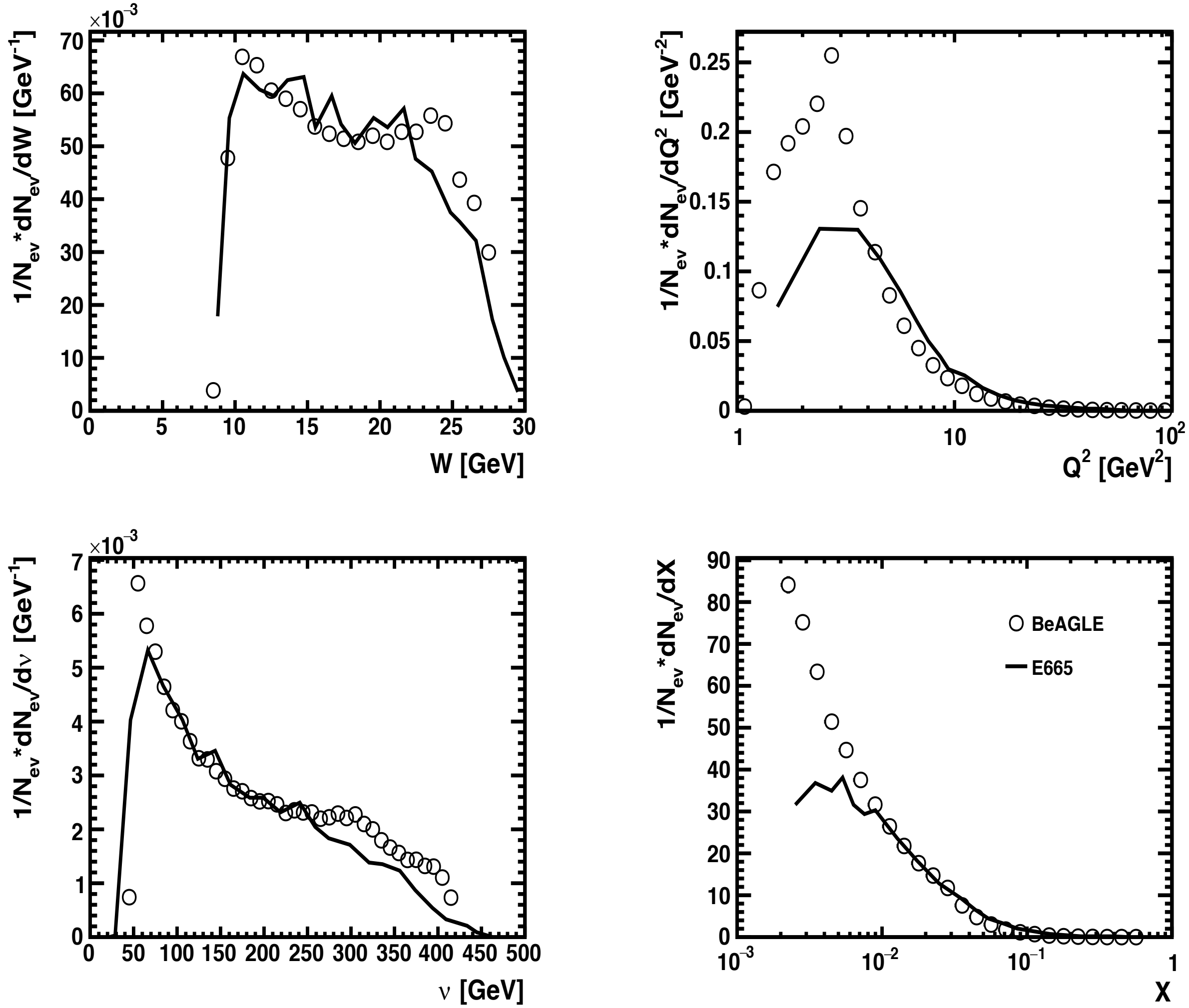
Z. Phys. C 61, 179-198(1994)

Data sample:

$\mu^{+}$+Xe
Beam momentum:
490 GeV × 0GeV

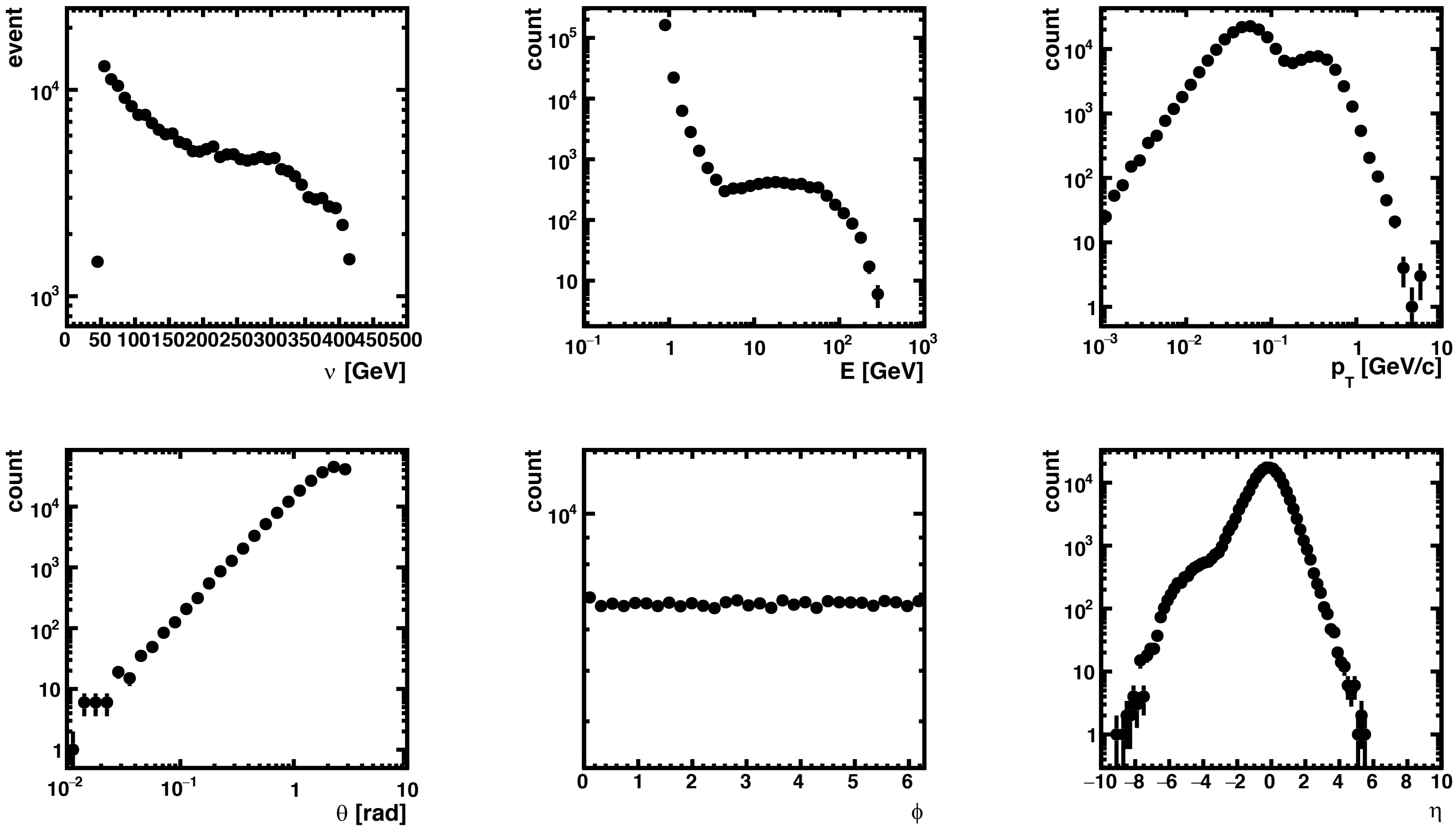
$0.1 < y < 0.85$
$1.0 < Q^2$<100
0.0035 rad < $\theta$ < 6.29 rad
8<W<30 GeV
X>0.002

40K events



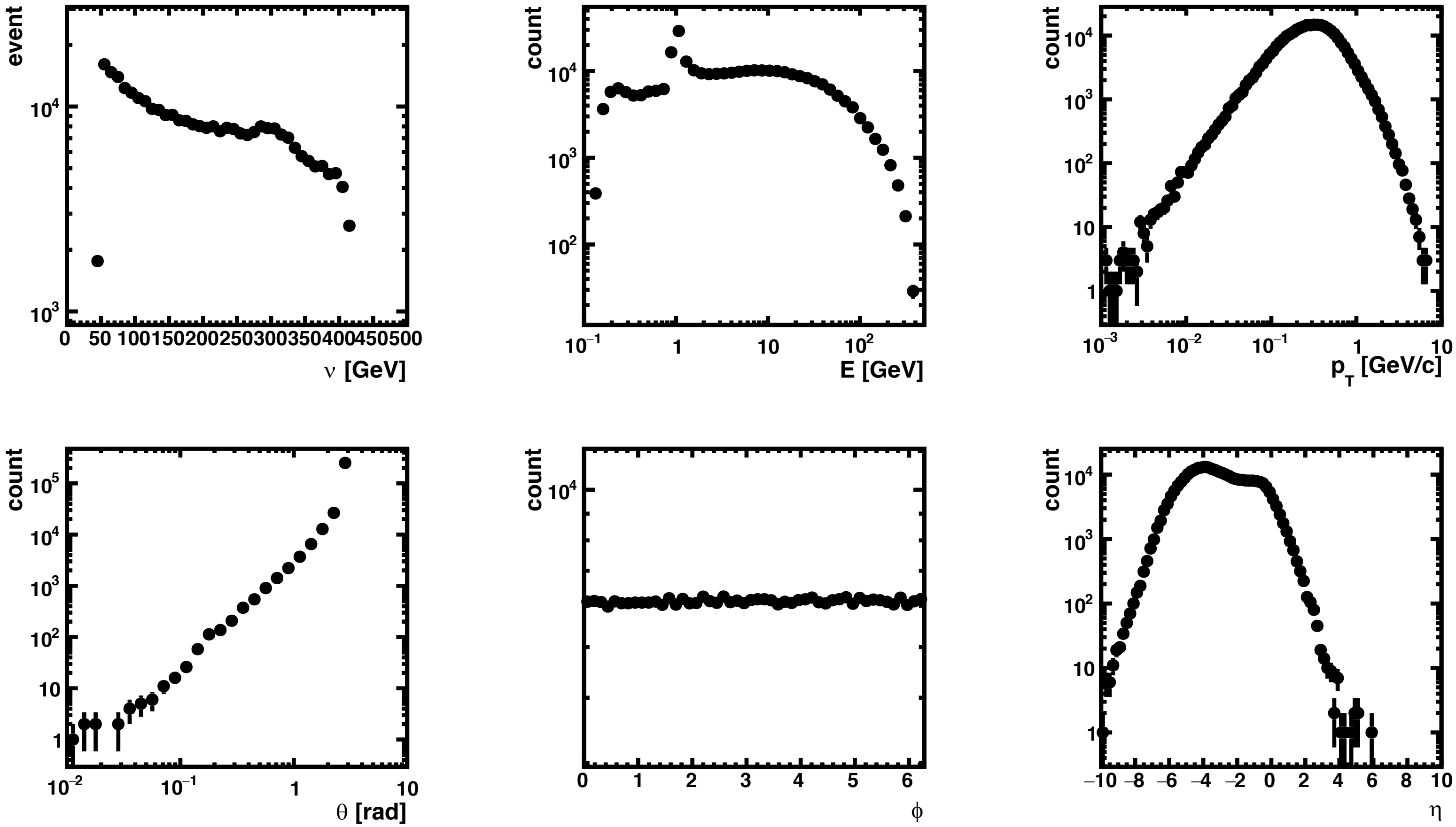
# Neutron

Raw distribution of $\upsilon, E, p_T, \theta, \phi, \eta$ for neutrons in the lab frame:



# Hadron

Raw distribution of $\upsilon, E, p_T, \theta, \phi, \eta$ for hadrons in the lab frame:



# To do …

To do the comparison on:

- Event kinematic (X, y, $Q^2$,$\upsilon$, $W$). VS Z. Phys. C 61, 179-198(1994)
- Track distribution($\upsilon, E, p_T, \theta, \phi, \eta, \frac{1}{N_{ev}}\frac{dN}{dy^*}$ ,….) VS Z. Phys. C 61, 179-198(1994)
- Multiplicity distributions(P(n), $\bar{n}$ , VS $W^2$) VS Z. Phys. C 61, 179-198(1994)
- The average total hadronic net charge$\langle Q_T \rangle$, the average number of grey tracks$\langle n_g \rangle$, and the difference of average charged backward multiplicities $\langle n_B \rangle_{\mu Xe} - \langle n_B \rangle_{\mu D}$ VS Z. Phys. C 65, 225-244(1995)
- Multiplicity ratio ($R_A^h = \frac{\left(\frac{N_h\left(\upsilon,Q^2,p_T^2,z\right)}{N_l\left(\upsilon,Q^2\right)}\right)_A}{\left(\frac{N_h\left(\upsilon,Q^2,p_T^2,z\right)}{N_l\left(\upsilon,Q^2\right)}\right)_D}$) VS HERMES collaboration
- And so on…….

E665 collaboration:
Z. Phys. C 61, 179-198(1994)
Z. Phys. C 65, 225-244(1995)
Phys. Rev. Lett. 74, 5198

HERMES collaboration:
arXiv:0906.2478
arXiv:hep-ex/0510030
arXiv:0704.3270
arXiv:1107.3496